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NAS CECIL FIELD
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# FINAL SUBMISSION FOR CONTAMINATION OF SOIL AND GROUND WATER RESULTING FROM THE RUPTURE OF THE DAY TANK FACILITY NAS CECIL FIELD FL

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GERAGHTY & MILLER, INC.

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FINAL SUBMISSION
CONTAMINATION OF SOIL AND GROUND
WATER RESULTING FROM THE RUPTURE
OF THE DAY TANK FACILITY, NAVAL AIR
STATION, CECIL FIELD, FLORIDA

Prepared for

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# INTRODUCTION

## Objective of the Investigation

In March 1981, Geraghty & Miller, Inc., was retained by Forrest A. Junck and Charles R. Walker, Architects, to determine the extent of ground-water contamination resulting from the rupture of the Day Tank facility located at the Naval Air Station, Cecil Field, Florida. Cecil Field is bisected by State Road 228 as shown in Figure 1. The Day Tank facility ruptured on the night of February 19, 1981, spilling a large quantity of JP-5 fuel oil, of which 280,000 gallons were recovered the following day by Jacksonville Spillage Control, Inc., and personnel from the Navy Department of Public Works.

The Day Tank is underlain by a subsurface drainage system connected to a storm sewer which discharges water into Sal Taylor Creek. Much of the fuel was recovered near the location of this outfall (Figure 2); however, some fuel flowed across the land-surface and ponded in two shallow land surface depressions which are depicted in Figure 3. Fuel was recovered from these depressions with a sump pump. Based on the hydrogeologic conditions at the site, the only potential location where fuel oil

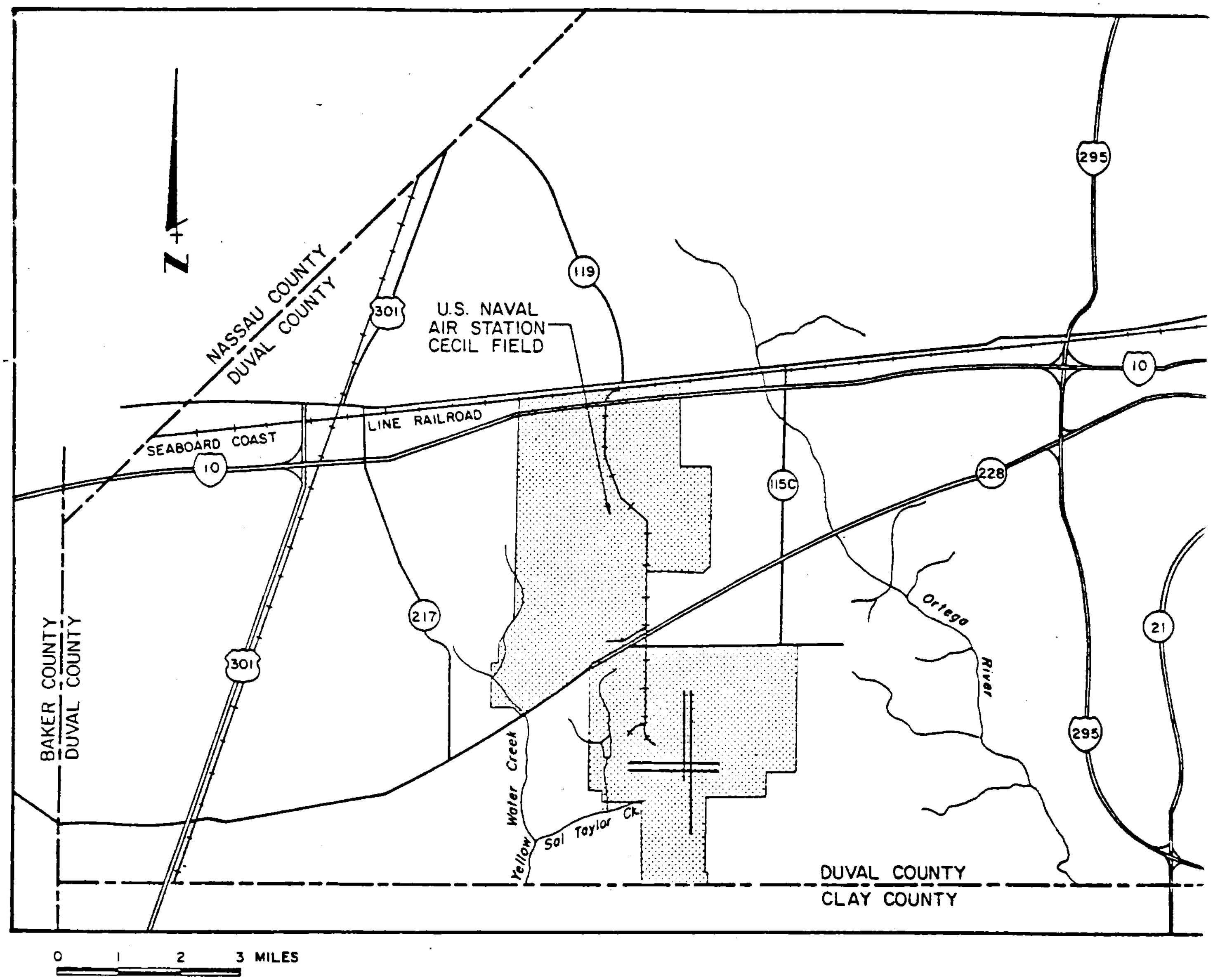


Figure 1. Regional Map Showing the Location of NAS Cecil Field.

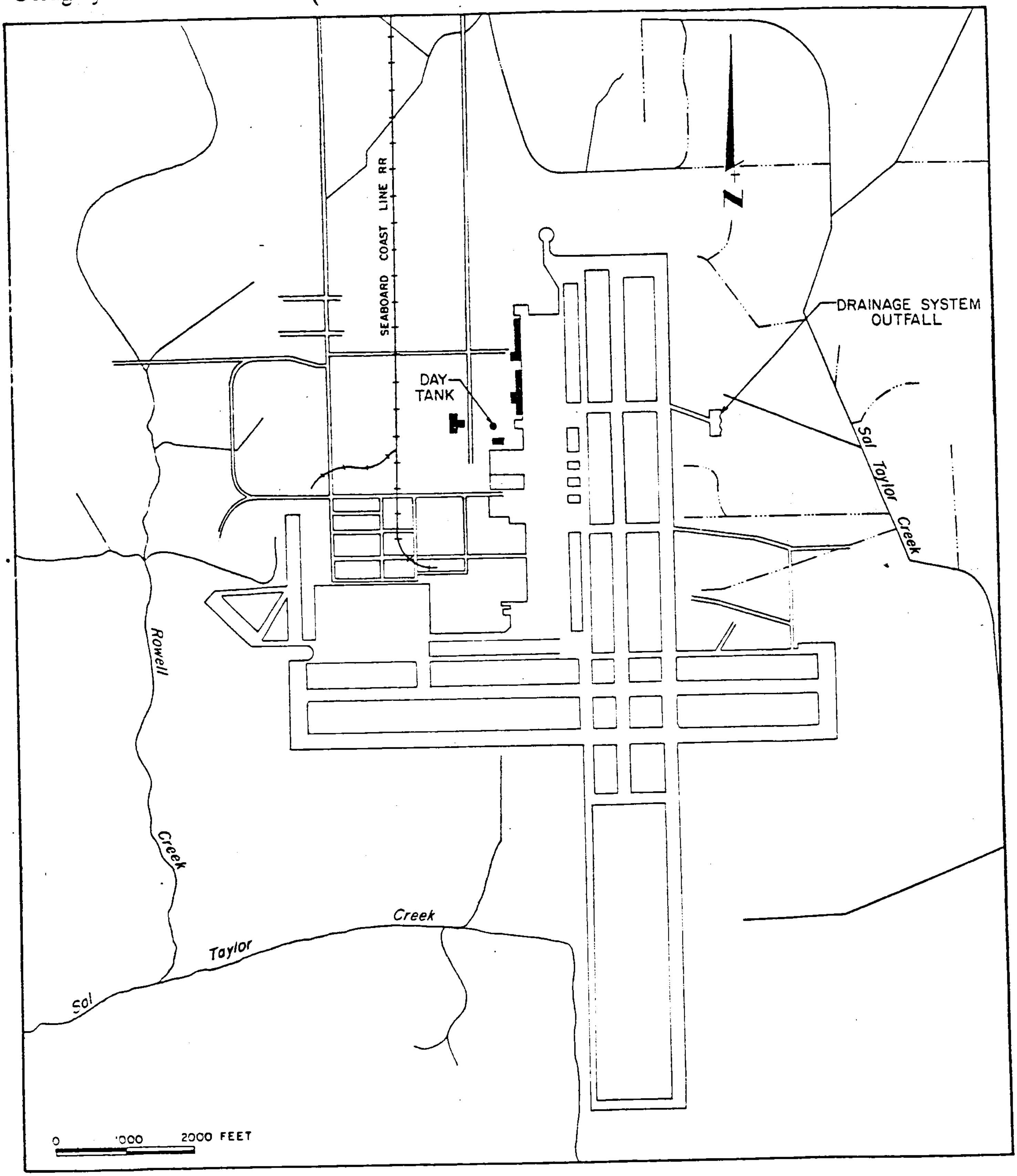


Figure 2. Location Map of Day Tank Facility and Drainage Outfall.

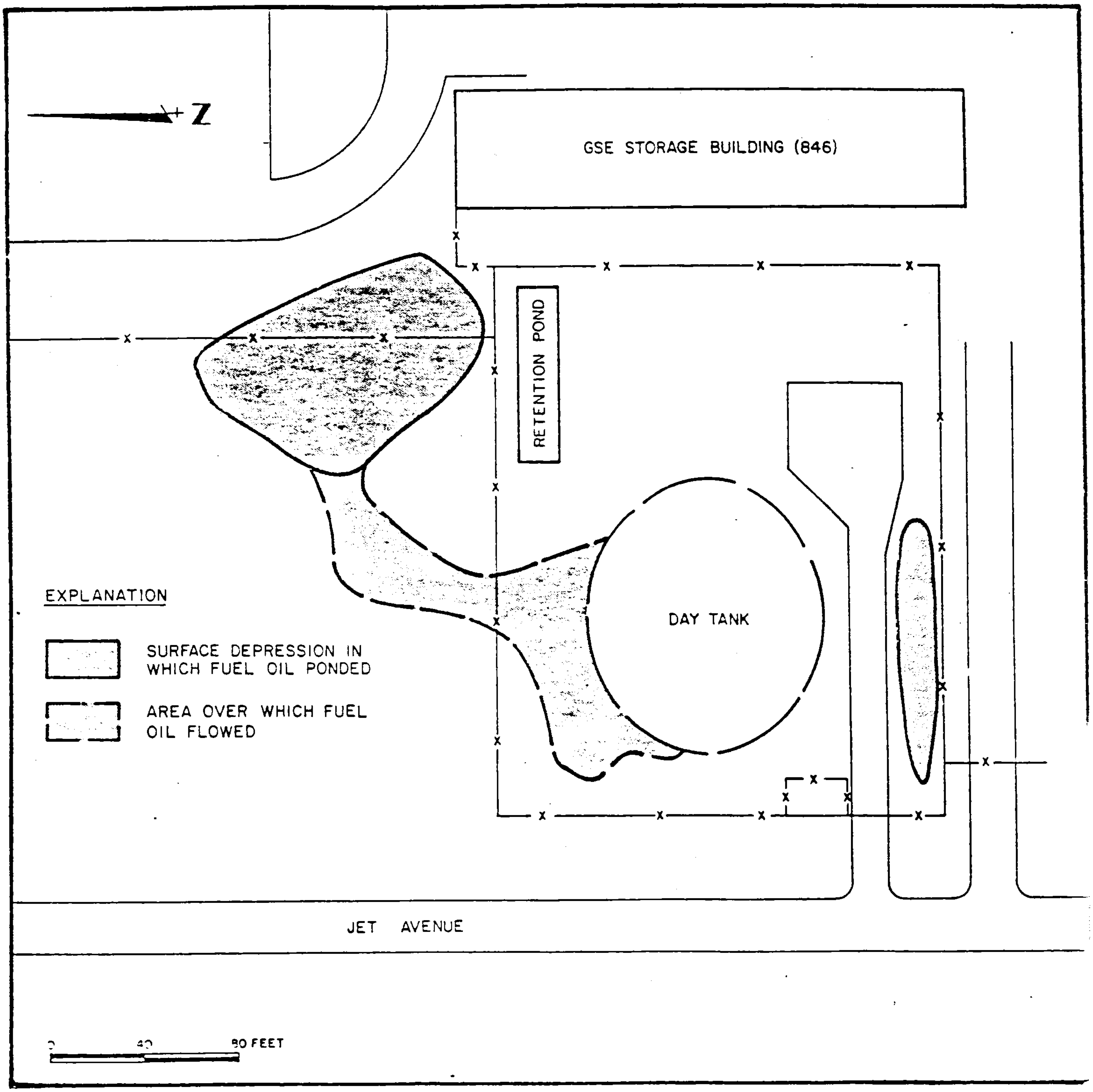


Figure 3. Surface Areas Affected by Fuel Oil Spill.

have entered the shallow ground-water system would be at the Day Tank facility. Therefore, the investigation was focused on determining the extent of ground-water contamination in this area.

## Basic Considerations

Movement of a fuel-oil body within the ground-water system is generally restricted to the unsaturated zone above the water table as fuel oil and ground water are immiscible. Once a fuel-oil body reaches the water table, downward seepage ceases and lateral migration begins within the capillary fringe. If, as in the case of this investigation, the influx of fuel oil ceases, capillary spreading becomes very slow and eventually a relatively stable condition is reached which is referred to as residual oil saturation or immobile saturation. Oil contained within the capillary fringe moves up or down concurrently with fluctuations of the water table, and is subject to biodegradation due to decomposition of the fuel oil by naturally-occurring bacteria. In order for the decomposition to occur, the bacteria must have access to adequate supplies of oxygen, moisture, nutrients, and carbon. Under these conditions, and if sufficient supplies of hydrocarbons and nutrients are available, the bacteria will consume the carbon, and release water and carbon dioxide as by-products.

## Work Performed in the Field

On March 10 and 11, 1981, a preliminary field investigation was performed consisting of seven auger borings which were drilled to the water table. Based on the analysis of the data collected from these holes, a more detailed field program was designed to define the extent and direction of migration of fuel oil in the surficial sediments.

During the week of June 15, 1981, the detailed field program was conducted consisting of 16 borings drilled at the locations shown in Figure 4. Although an attempt was made to drill within the fenced area of the Day Tank, it was not possible due to the presence of piping, underground utilities, and the cathodic protection system in the subsurface around the tank. During the drilling, the physical and mineral characteristics of the soil samples were described by a hydrogeologist from Geraghty & Miller, Inc., who also determined the presence or absence of fuel oil in the soil samples by smell and by visual inspection.

Five of the soil borings were converted to monitor wells (Figure 4), each of which consisted of a 2-inch-diameter PVC pipe with a 3-foot-long screened section attached to the bottom. A graded sand was placed around the screen, and the remainder of the borehole was backfilled to land surface. A schematic

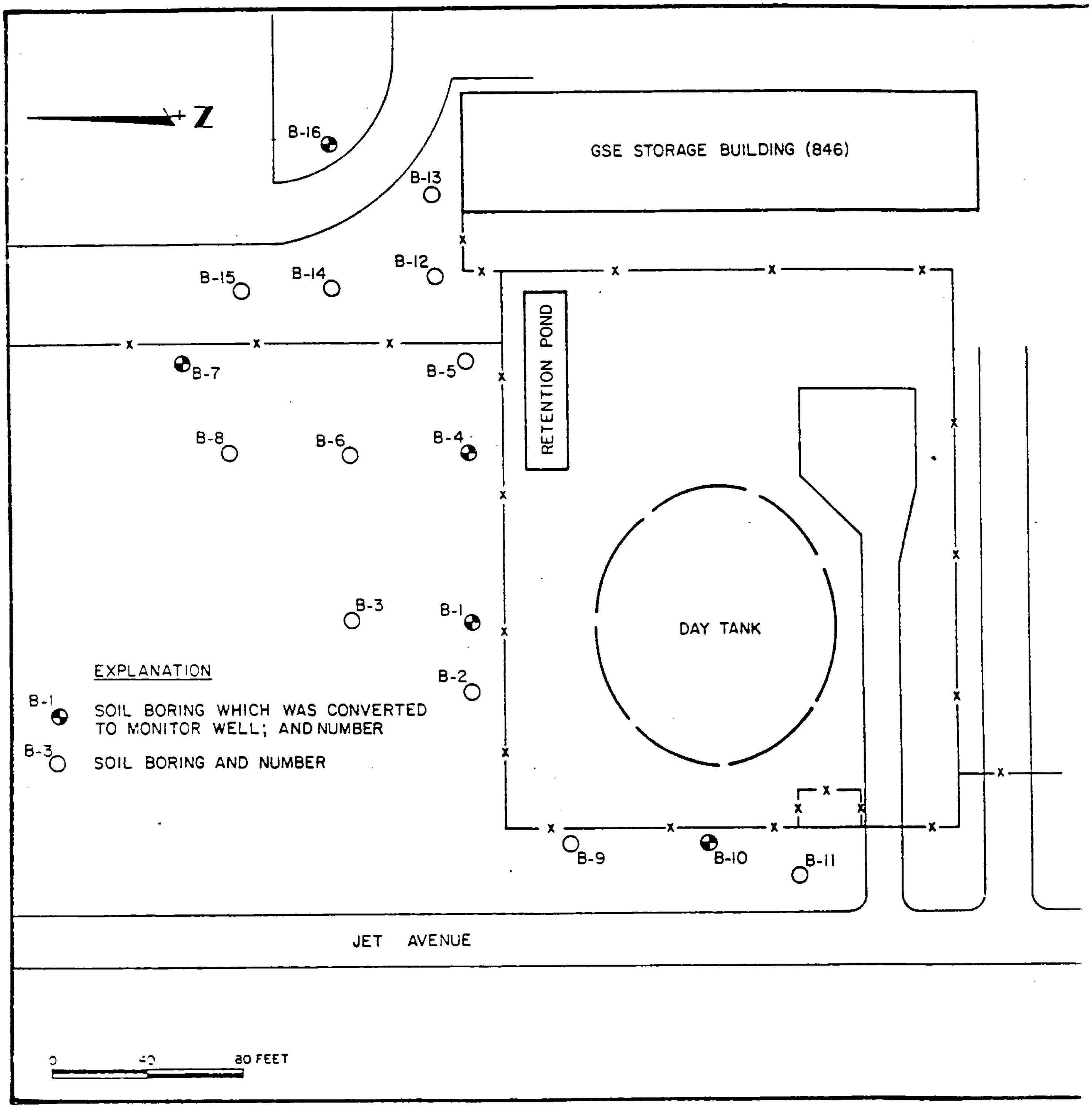


Figure 4. Locations of Borings Drilled and Monitor Wells Installed During the Field Program.

diagram depicting the typical construction details of the monitor wells is shown in Figure 5; Table 1 indicates the construction details for each of the five wells. An attempt was made at each site to set the well at a depth which would allow the screened section to intersect the water table. This was done in order to enable the measurement of the thickness of the fuel oil floating on the water table.

After each well was installed, water-level measurements were taken daily until completion of the field program. The top of the casings, which were the measuring points, were then surveyed so that the water-level measurements could be referenced to mean sea level and the direction of ground-water flow could be determined.

On July 16, 1981, water samples were collected from each of the monitor wells to obtain additional data on the movement of the oil body from the unsaturated zone into the saturated zone after several inches of rain had fallen throughout the area.

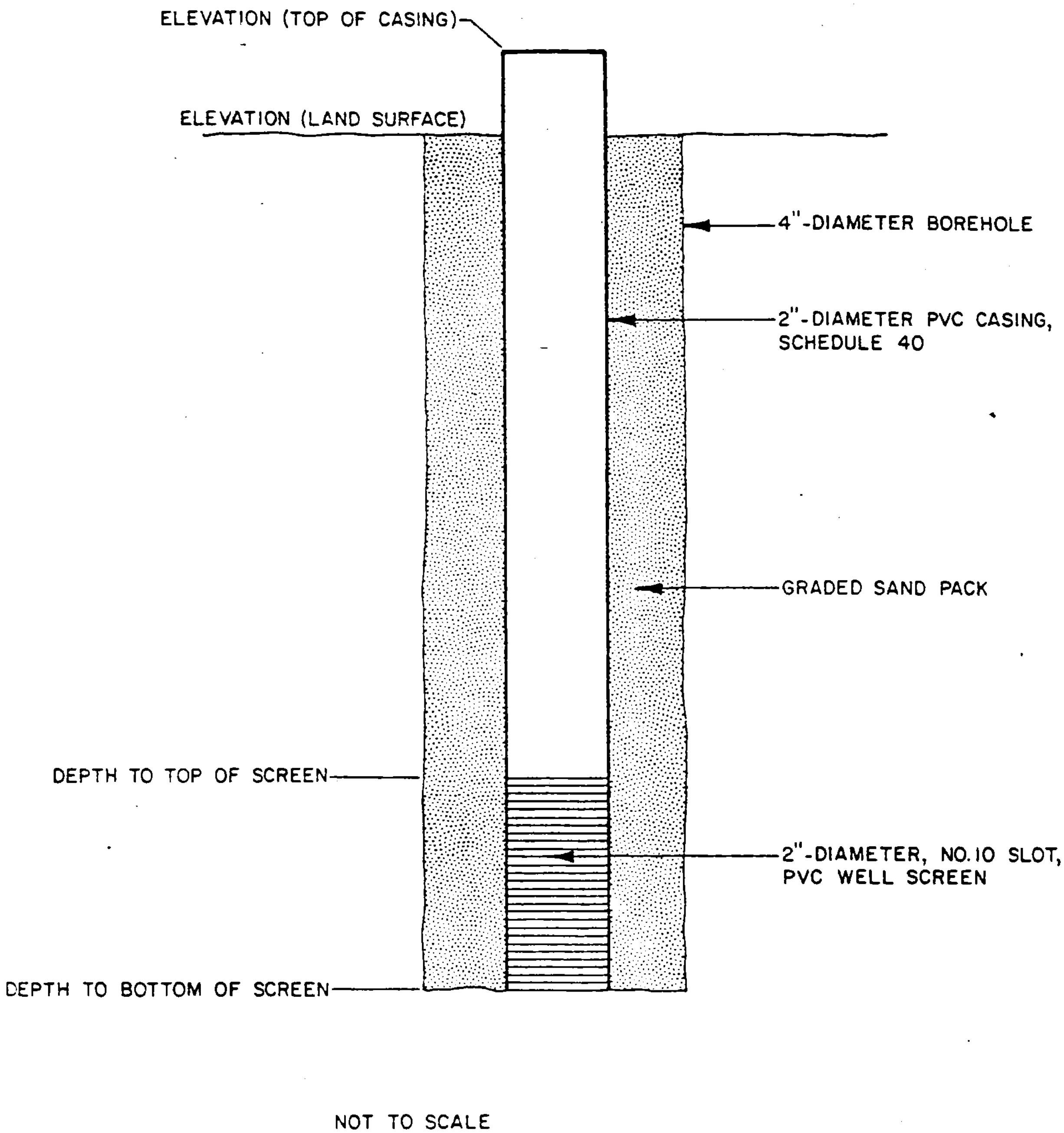


Figure 5. Typical Well-Construction Details.

Table 1. Details of Monitor Wells Installed During the Field Program

| Well No. | Depth to Top of Screen (feet) | Depth to Bottom of Screen (feet) | Top of Casing Elevation (feet, msl)[1] | Land Surface Elevation (feet, msl)[1] |
|---|---|---|---|---|
| B- 1 | 8 | 11 | 81.89 | 80.0 |
| B- 4 | 7 | 10 | 81.45 | 79.28 |
| B- 7 | 7 | 10 | 81.51 | 79.17 |
| B-10 | 8 | 11 | 82.39 | 80.26 |
| B-16 | 9 | 12 | 81.49 | 79.36 |

[1] Elevation of benchmark was approximated.

# HYDROGEOLOGIC FRAMEWORK

## Topography, Drainage, and Surficial Geology

The topography at the study site is basically flat with numerous shallow land-surface depressions. Land-surface elevations at the site average about 80 ft msl (feet mean sea level). Surface-water drainage is conveyed primarily through storm-sewer systems to canals and low areas which drain to Sal Taylor Creek.

The geology of the upper 10 ft (feet) of earth materials consists of an upper 6 in (inches) of top soil which is underlain with very fine to fine-grained sand with varying amounts of silt. A layer of very dense reddish-brown hard pan was encountered in each of the borings at a depth of approximately 6 ft. Geologic logs of the soil borings are presented in Appendix A.

Water-level measurements taken on July 23, 1981, indicate that the water table slopes slightly to the east or southeast (Figure 6); thus ground-water flow in the surficial sediments is in an east or southeast direction, eventually discharging into Taylor Creek (Figure 2).

Using an estimated hydraulic conductivity of 28 ft per day (which is typical for the fine-grained silty sands encountered at the site), a porosity of 35

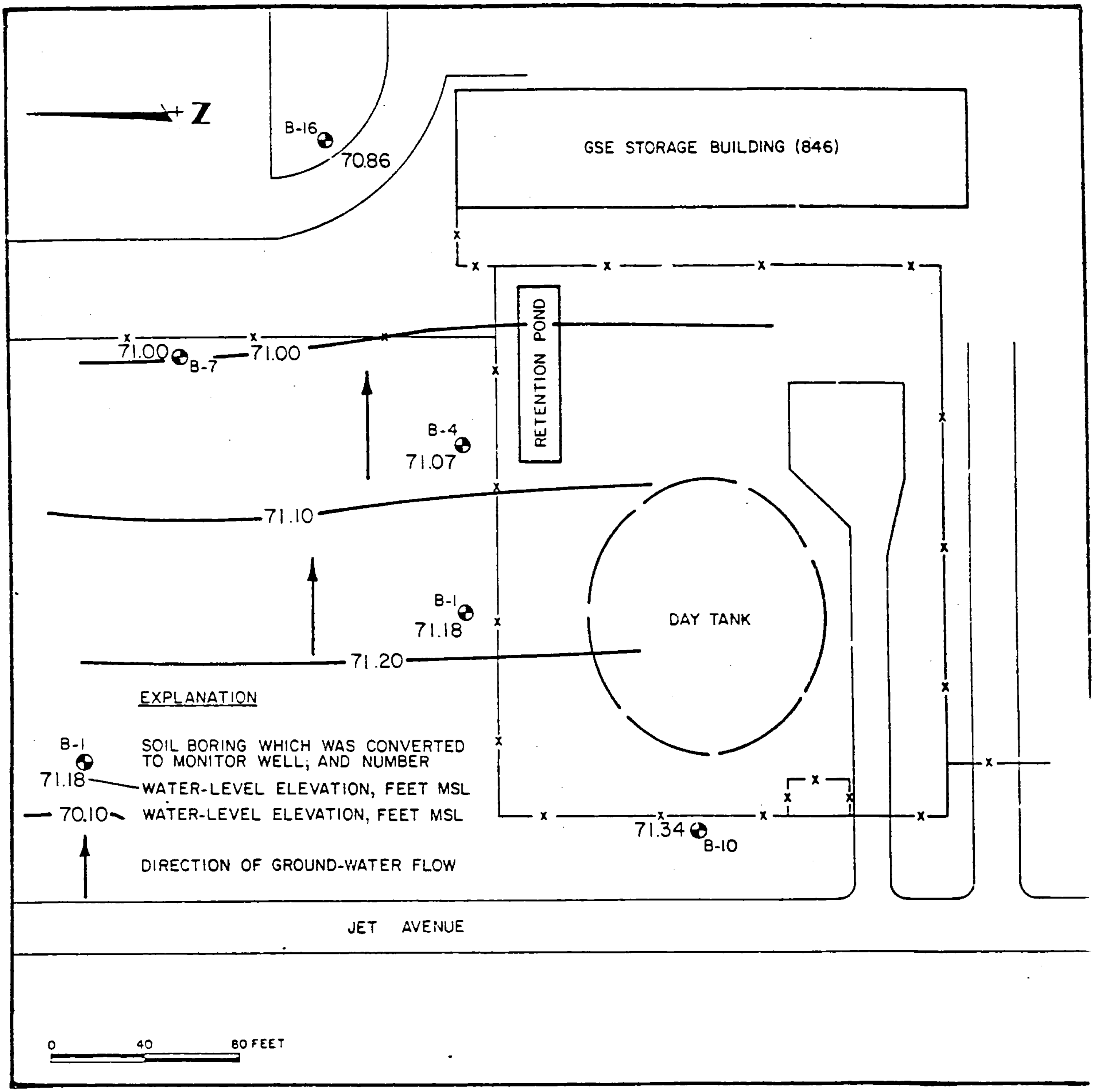


Figure 6. Ground-Water Elevations at Site Based on Measurements Taken on July 23, 1981.

percent, and the prevailing hydraulic gradient, the ground-water flow rate is estimated to be 40 ft per year.

## LOCATION OF THE FUEL OIL IN THE GROUND-WATER SYSTEM

Fuel oil which spilled from the ruptured Day Tank flowed across the land surface and either ponded at the locations shown in Figure 3, or it flowed into the storm sewer and discharged into Sal Taylor Creek. Therefore, the only potential areas where the ground water could be contaminated by the fuel oil are those areas shown in Figure 3.

In order to delineate both horizontally and vertically the location of the fuel oil in the shallow ground-water system, soil borings were installed at the locations shown in Figure 7. As indicated in this figure, the only soil borings which were found to contain fuel oil were those drilled in areas where the fuel oil flowed across land surface or where it ponded. All other borings, including those immediately adjacent to the locations where the fuel oil ponded, did not detect the presence of fuel oil.

Borings B-1, B-4, B-7, B-10 and B-16 were converted to monitor wells, and analyses of water samples collected from these wells did not show the presence of fuel oil. Based on these results and on observations in the field, it was concluded that the fuel oil was present only in the unsaturated zone above the water table in the areas identified in Figure 3. In this

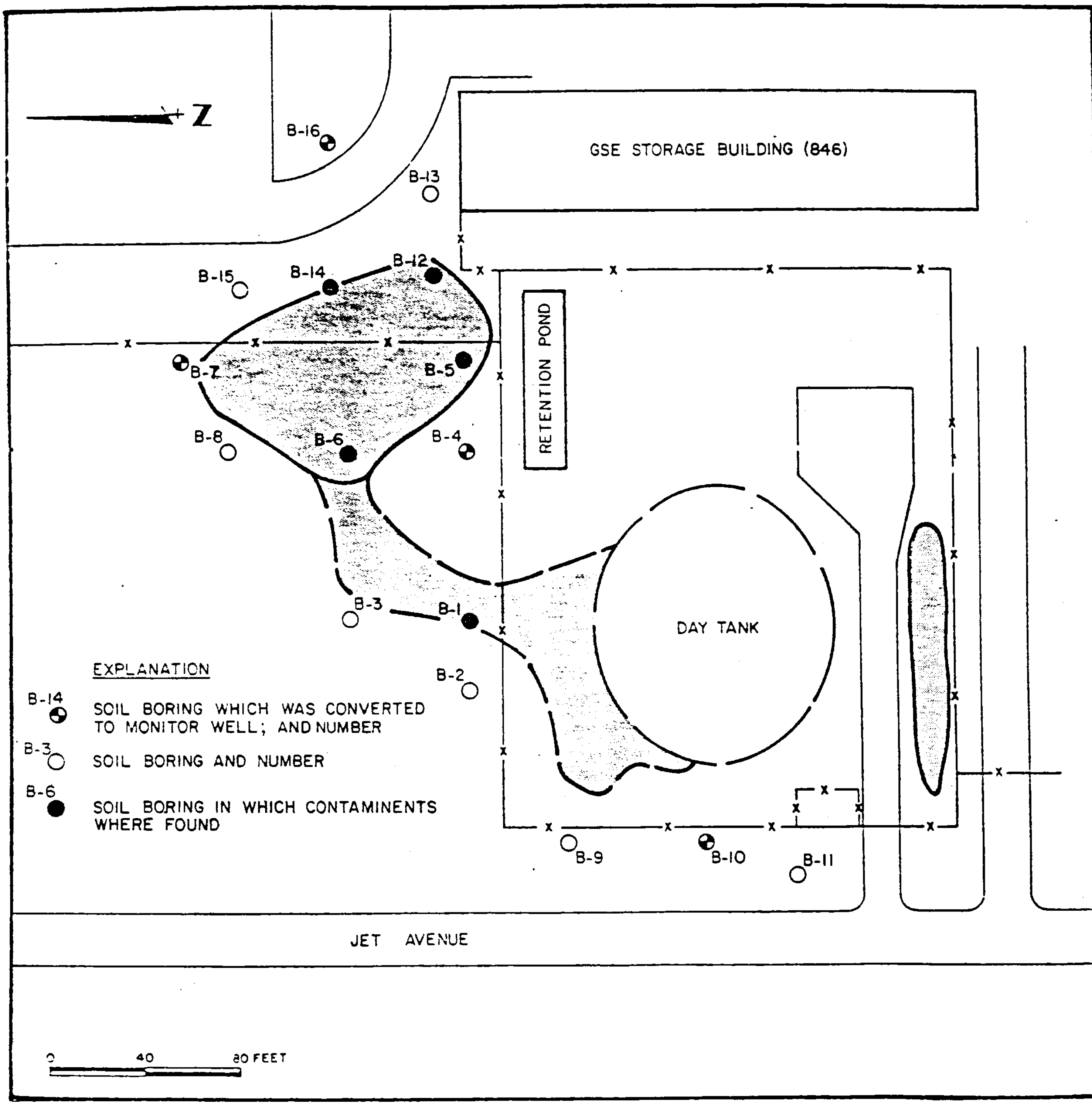


Figure 7. Surface Areas Affected by Fuel Oil Spill and Borings Found to Contain Contaminated Soil Samples.

regard, it should be noted that although no borings could be installed within the fenced area, it is believed that the conditions within the fenced area are similar to those found outside the fenced area.

A second field trip was made to the site five weeks after the drilling program had ended. The purpose of the visit was to resample the monitor wells to determine whether or not the fuel oil in the unsaturated zone had migrated downward and, due to the downward percolation of rainwater, had formed a plume on top of the water table. No plume could be detected; therefore, it is concluded that only a small amount of fuel oil has migrated into the shallow ground-water system and that the amount of fuel oil is small enough so that no significant oil plume has or will be formed. The fuel oil is simply present in the unsaturated zone between the water table and land surface in the areas depicted in Figure 3 and will biodegrade into carbon dioxide and water over a period of time due to naturally-occurring bacteria.

## RECOMMENDATIONS

### Abatement Program

There is no cost-effective way of recovering fuel oil from the unsaturated zone because the fuel oil has a physical affinity to the soil particles and thus has a tendency to "cling" to these particles. Although the fuel oil in the ground water near the Day Tank could be floated out by flooding the area, the recovery rate would be minimal unless a surfactant, such as a detergent, were used to overcome the physical affinity between the fuel oil and soil particles. If the fuel oil were floated out using a surfactant, the liquid waste product would have to be conveyed to a wastewater-treatment facility.

Therefore, based on the findings, it is recommended that no attempt be made to recover the limited amount of fuel oil tied up in the unsaturated zone. Over a period of time, the fuel oil will decompose naturally due to bacteria in the unsaturated zone. As stated earlier, in order for decomposition to occur, the naturally-occurring bacteria requires adequate supplies of oxygen, moisture, nutrients, and carbon. Because the fuel oil provides the source of carbon, and moisture is provided naturally by rainfall, the amounts of oxygen and nutrients available in the unsaturated zone are the limiting factors on the rate of decomposition of the fuel oil. Although there are in situ biological treatment systems available for the treatment of hydrocarbons in the ground water, such as the system developed by Suntech, Inc., these systems are not effective in destroying hydrocarbons in the unsaturated zone.

The in situ biological treatment systems involve the introduction of nutrients and oxygen into the earth materials to increase the population of carbon-destroying bacteria present in the soil. Because oxygen is already available in the unsaturated zone, decomposition will occur if sufficient nutrients are available. Therefore, Geraghty & Miller, Inc., has modified the in situ biological treatment process so that natural decomposition of hydrocarbons in the unsaturated zone is accelerated.

To achieve this accelerated rate of decomposition, a 12-6-6 type lawn fertilizer should be applied monthly to the area shown in Figure 3 at an application rate that is three to four times the recommended lawn application rate. After the fertilizer has been applied, the area should be watered by the spray irrigation method at a rate equivalent to about three to four inches per application. These procedures should be followed for a period of six months.

If it is required to remove some soil enclosing the Day Tank in order to make repairs to the tank, it is suggested that the soil be spread out in the same areas where the fuel oil is already present in the unsaturated zone. Fertilizer and moisture should be applied in the same manner as discussed above. This will promote the decomposition of fuel oil tied up in the soil. After about six months, the decomposition of most of the fuel oil should be completed and the soil can either be seeded or it can be repacked around the Day Tank.

## Monitoring Program

Since the fuel oil has essentially reached immobile saturation, the five monitor wells which were installed during this program will not be needed to determine future migiration of the fuel oil. Therefore, it is recommended that these wells be used to monitor the success of the proposed treatment process. Prior to initiating the treatment process, water samples should be collected from each of the monitor wells and analyzed for the presence of carbon dioxide ($CO_2$), bicarbonate ($HCO_3$), and nitrate. This will establish baseline levels and will be used to monitor the success of the treatment program. Since carbon dioxide is a byproduct of the decomposition process, high concentrations of carbon dioxide and bicarbonate in the downgradient wells will be indicative of the success of the the treatment program. Increased nitrate in the downgradient wells will indicate whether the fertilizer is moving past the root zone and is reaching the water table. Therefore, after the treatment program is initiated, monthly water samples should be collected from each of the wells and analyzed for carbon dioxide, bicarbonate, and nitrate.

Respectfully submitted,

GERAGHTY & MILLER, INC.

Peter L. Palmer, P.E.
Senior Scientist

Daniel W. Rothenberger
Hydrogeologist

# APPENDIX A

Lithologic Logs

Geraghty & Miller, Inc.

Table A-1. Lithologic Log of Boring B-1.

| Description | Depth (ft) | Thickness (ft) |
|---|---|---|
| Sand; quartz, very fine to fine-grained, silty, gray to black | 0 - 3 | 3 |
| Sand; quartz, very fine-grained, silty, dark brown | 3 - 4.5 | 1.5 |
| Sand; quartz, very fine-grained, very silty, brown | 4.5 - 7 | 2.5 |
| Sand; quartz, very fine-grained, silty, light brown, trace of clay | 7 - 8 | 1 |
| Sand; quartz, very fine to fine-grained, silty, tan | 8 - 9.5 | 1.5 |
| Sand; quartz, very fine to fine-grained, silty, tan | 9.5 - 11 | 1.5 |